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Teacher's Guide

The Super Factory

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IBM PC/PCjr
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THE SUPER FACTORY
INTRODUCTION

"A few years ago, a high school student attracted national attention by catching an error in the mathematics portion of the Preliminary Scholastic Aptitude Test. The question involved asking students to find the number of exposed faces on a solid, three-dimensional shape.

Most of the public's attention focused on the furor over an error on the P.S.A.T. But the incident highlights a very real problem in the way mathematics is taught. In this three-dimensional world, we teach two-dimensional math. The study of three-dimensional shapes has been put on the back burner.

Both the natural world and the world created by technology abound with geometrical forms, forms that must be both seen and understood by anyone who wants to deal intelligently with these worlds. Yet ignorance of the elementary properties of spatial geometry is profound. We teach our children a great deal about triangles but almost nothing about the tetrahedron, a principal building block in constructions from the atomic structure of metals to the supports of giant bridges."

From Education Week, "Two Dimensional Math in a Three Dimensional World", Marjorie Senechal, George Fleck, February 6, 1985.

THE SUPER FACTORY was designed to take students into a three-dimensional world. As an extension of *THE FACTORY*, it focuses on the problem-solving strategies of working backwards, analyzing a process, and determining a sequence.

THE SUPER FACTORY consists of three levels:

- Research - Allows students to explore three-dimensional objects. Students can "play" with a three-dimensional cube; they can try returning the cube to its starting position.

- Design - Allows students to plan a strategy and execute it.

- Challenge - Confronts the students with a problem to solve. They must duplicate the pictures on the faces of a cube. How do they go about solving the problem? What strategies can they use? How should they approach it?

Special features of *THE SUPER FACTORY* include:

The ability to store a cube made by students or the teacher and have other students try to duplicate it.

The emphasis on G. Polya's four steps of problem-solving in the Challenge level. The four steps can be reinforced through classroom lessons (see Lesson 2 - page 33).

The ability to change the objects on the cube. Some objects are rotationally symmetric - this means that when you rotate them 90°, 180°, or 270°, they do not change in appearance. A square is an example of a rotationally symmetric object. A triangle would not be rotationally symmetric. Students can begin working with objects that are rotationally symmetric - which would make the problems easier - then advance to harder challenges.

Please note: *THE SUPER FACTORY* will be difficult for most students. It is assumed that the teacher will use the lesson plans and help the students find strategies to tackle the problems.

THE SUPER FACTORY teaches the students the strategy of working backwards. When working backwards, you solve the problem by determining what the final result should be and then working backwards to find what steps will give you that result.

The program also involves the strategies of:

Analyzing - breaking down the problem, solving it in parts, if possible, and identifying necessary and unnecessary information.

Looking for a sequence - finding order and discovering relationships.

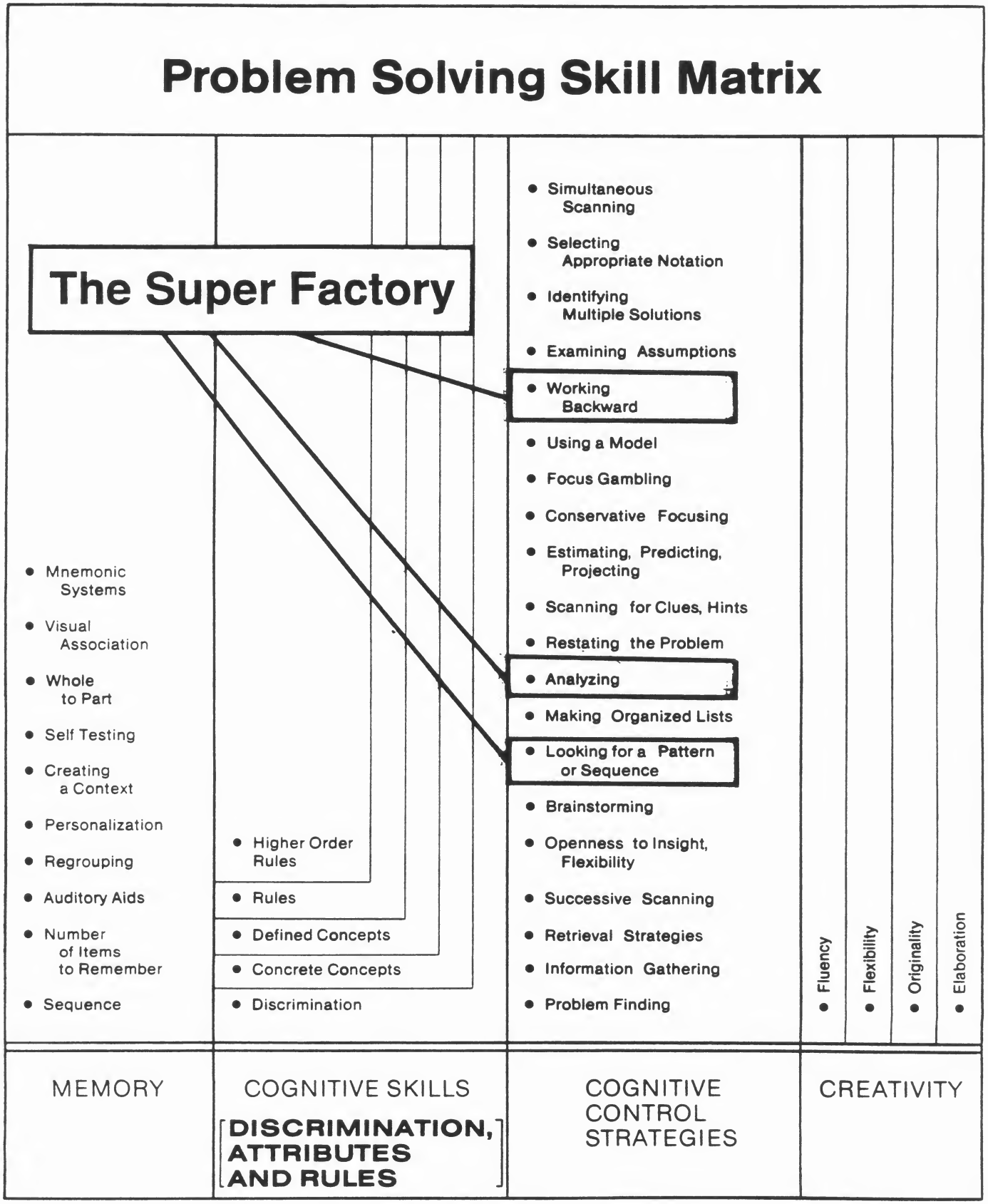
Rotation - understanding and applying the mathematical concept of rotation and rotational symmetry.

The program is designed for:

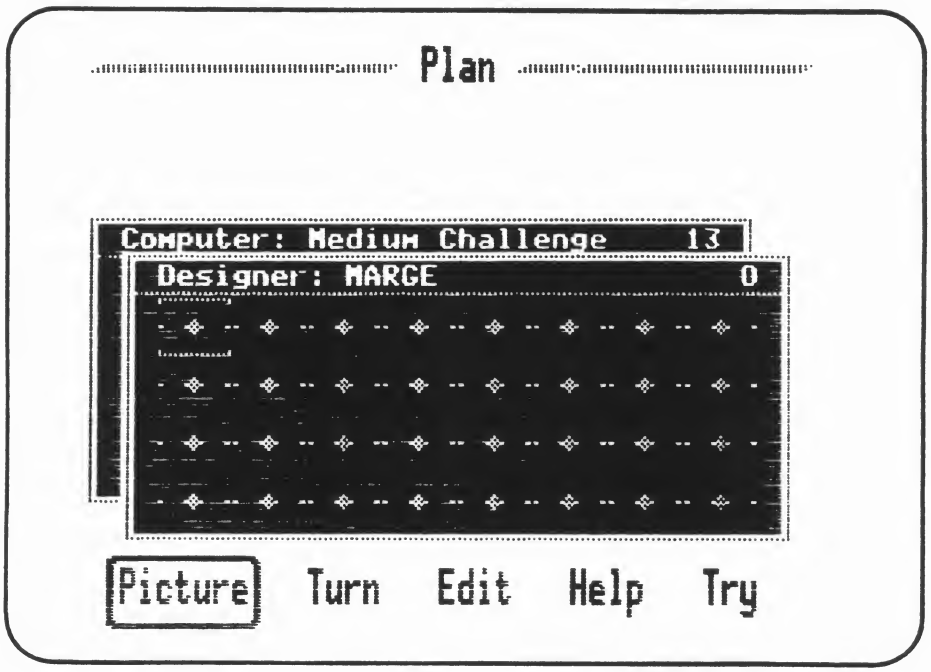
- a 64K Apple II+, IIe, IIc or IIGS
- an IBM PC, PCjr with 128K and a graphics card,
- or a Tandy 1000.

If you need assistance in operating your computer, check the section of this Teacher's Guide entitled "Working With Your Computer" and "What Happens If...?" You can also call Sunburst Communications toll-free at 800 - 431 - 1934.

Problem Solving Skill Matrix



THE SUPER FACTORY
OBJECTIVES



Skills: Working Backwards
Visual Imagery
Spatial Perception

Grade Level: 5 - Adult

Reading Level: 4th grade (Fry)

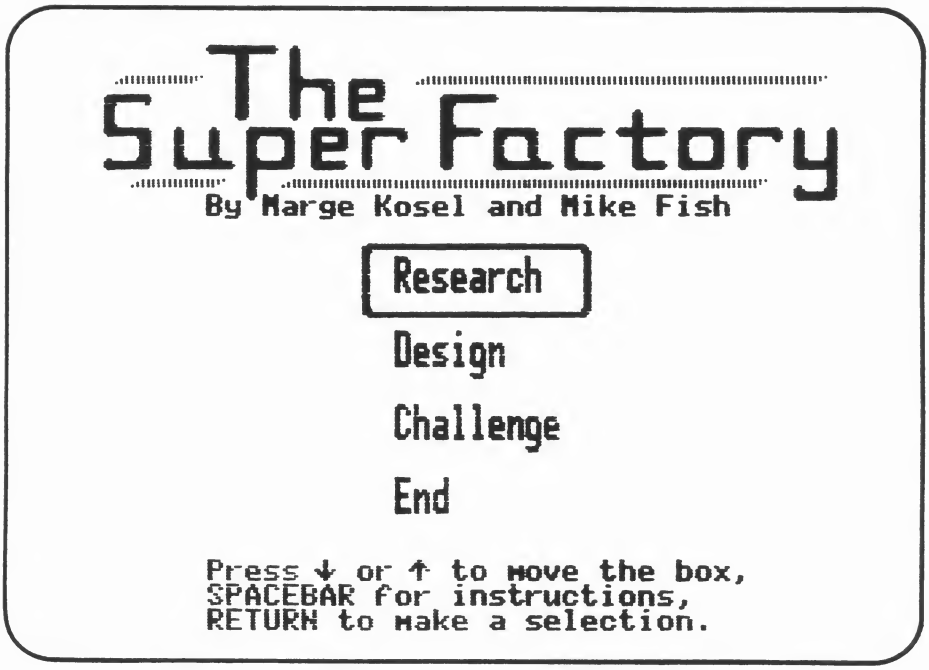
Objectives:

1. To provide students with an environment in which they can manipulate and become familiar with the properties of a three-dimensional cube.

2. To teach students the four steps of problem solving.

3. Through classroom lessons, to provide students with a way of approaching and tackling a problem.

THE SUPER FACTORY
PROGRAM DESCRIPTION



Description

Students are first presented with the main menu from which they can access the three main sections of the program. They can choose: Research, Design, or Challenge. End exits them from the program.

Students can go to any section. When first using the program, however, they should be encouraged to start with Research and progress to Challenge.

To make a selection, students press the arrow keys to move the box.

- On an Apple IIe, IIc, or IIGS, use the ↑ or ↓ arrows
- On an IBM PC, or PCjr, use the ↑ or ↓ arrows
- On a Tandy, use the ↑ or ↓ arrows
- Or on an Apple II+, they can use the → or ← keys

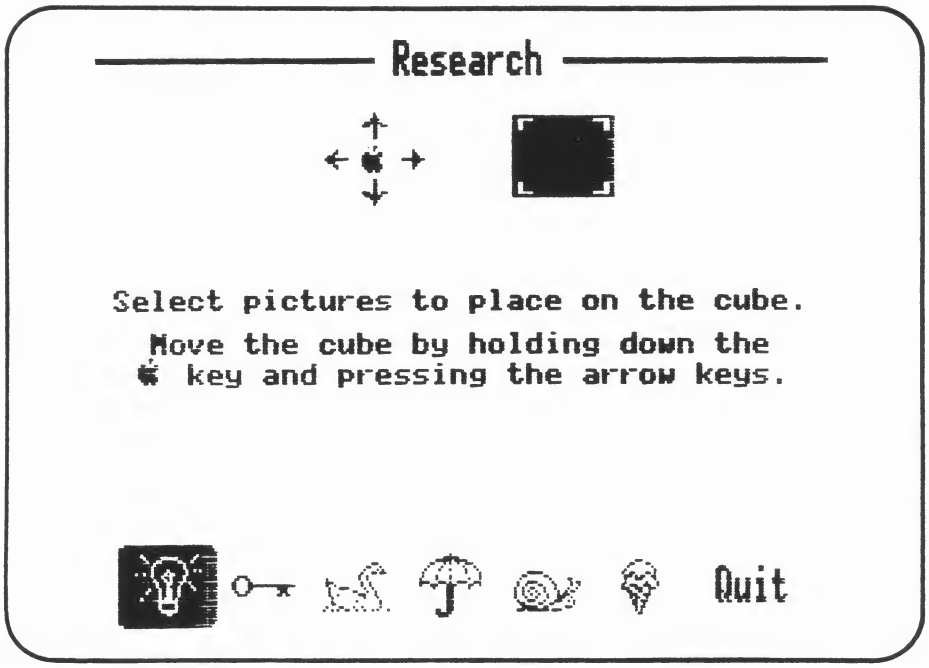
By pressing the SPACEBAR, they will see a description of that section of the program. By pressing the RETURN key (↵ on the IBM or Tandy), they will go to that section of the program.

In the Research section, students experiment with a cube and become familiar with the mechanics of the program. They build a cube by rotating it and selecting pictures to place on the faces.

In the Design section, students build cubes, but at a more advanced level. They design a plan consisting of pictures and turns (rotations). The pictures will not appear immediately on the cube as in the Research section; they are placed on the cube as the plan is executed.

In the final section, the students select a Challenge ranging in difficulty from Easy to Super. The object is to build a duplicate of the challenge cube. Students can also build their own cubes in the Design section and challenge their fellow students to reproduce them in the Challenge section.

THE SUPER FACTORY
RESEARCH



In Research, students start with a blank cube. The cube is rotated in the following manner.

- On the Apple IIe, IIc, or IIGS, the cube can be rotated by holding down the closed apple key (🍎) and pressing an arrow key.
- On the Apple II+, use the I, J, K and L keys to rotate the cube, instead of the closed apple and arrow keys.
- On the IBM and Tandy, the cube is rotated by holding down the SHIFT key and pressing an arrow key.

(Please note that the cube will rotate in this manner throughout the program.)

The arrows to the left of the cube indicate the direction of movement while the cube is rotating.

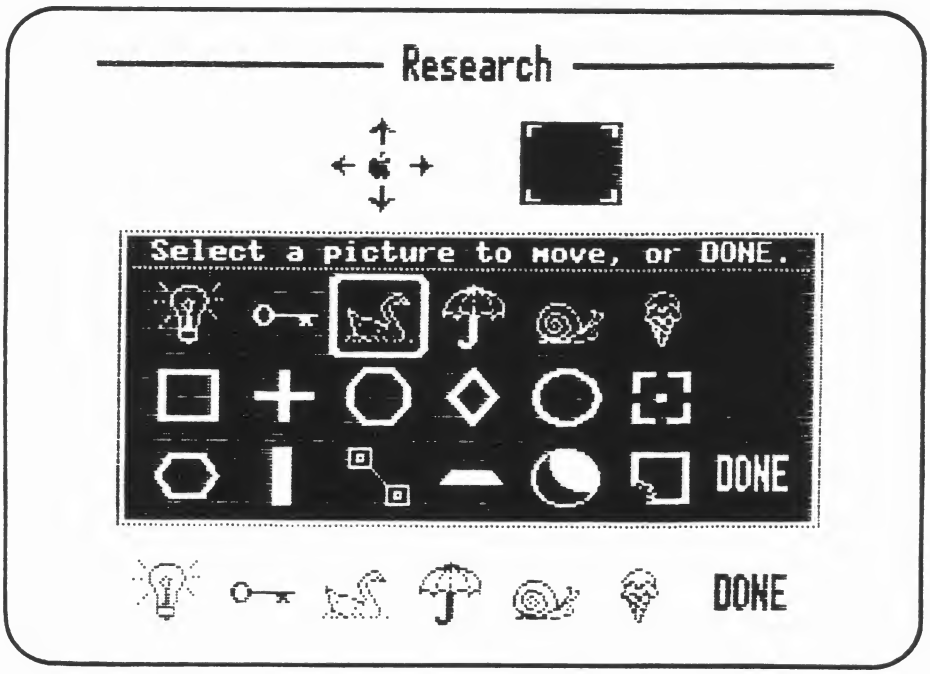
Six different pictures can be placed on the faces of the cube. To select a picture, use the arrow keys to move the highlighting to that picture and then press RETURN (↵ on the IBM or Tandy). That picture appears immediately on the front face of the cube. To replace a picture, simply move the highlighting to another picture and press RETURN (↵ on the IBM or Tandy). The original picture will be replaced.

A particular picture can be chosen more than once. Sides of the cube may be left blank. If more than one picture is placed on a particular face, the last picture is shown.

When the cube is rotated, it is important to note how the pictures change orientation, i.e., they are upside-down or sideways.

The program begins with a set of six pictures that students may place on the cube; such as:

By pressing the P key, the student will be able to select from 18 different pictures. The teacher can also select the beginning set of pictures in the Change Option (see page 23).



To select a different set of pictures, move the box using the arrow keys to the new picture and press RETURN (↵ on the IBM or Tandy). Now move the highlighting to the picture to be replaced and press RETURN (↵ on the IBM or Tandy). When you have made all the changes, move the box to DONE and press RETURN (↵ on the IBM or Tandy). These new pictures can then be placed on the cube.

Certain pictures are easier to work with than others because they do not change in appearance when the cube is rotated. Through experimentation, you will find that rotationally symmetric pictures are easier. These pictures will not change when they are turned, thus will not appear different when upside-down or sideways.

Some of the pictures presented are symmetrical with respect to 180° turns and some are asymmetrical. Experiment with different figures to see the results.

RESEARCH

Although the Research section may seem trivial, it is here you should learn some basic features of the cube. Experiment with the cube. Try to bring it back to the front face. Try taking a certain side and flipping it upside-down. Try working with different pictures.

In Research, as in other sections of *THE SUPER FACTORY*, the front face of the cube is identified by marks in its corners. In Research, you can use these marks as a starting position when rotating the cube. In Challenge, you must have the two cubes match starting with the front face.

After having researched the cube, you can end this section by moving to QUIT and pressing RETURN (↵ on the IBM or Tandy). You can then choose to research another cube or proceed to Design, Challenge, or End.

At any point in the program, students may exit the program and return to the main menu by holding down the CONTROL key and pressing the E key at the same time.

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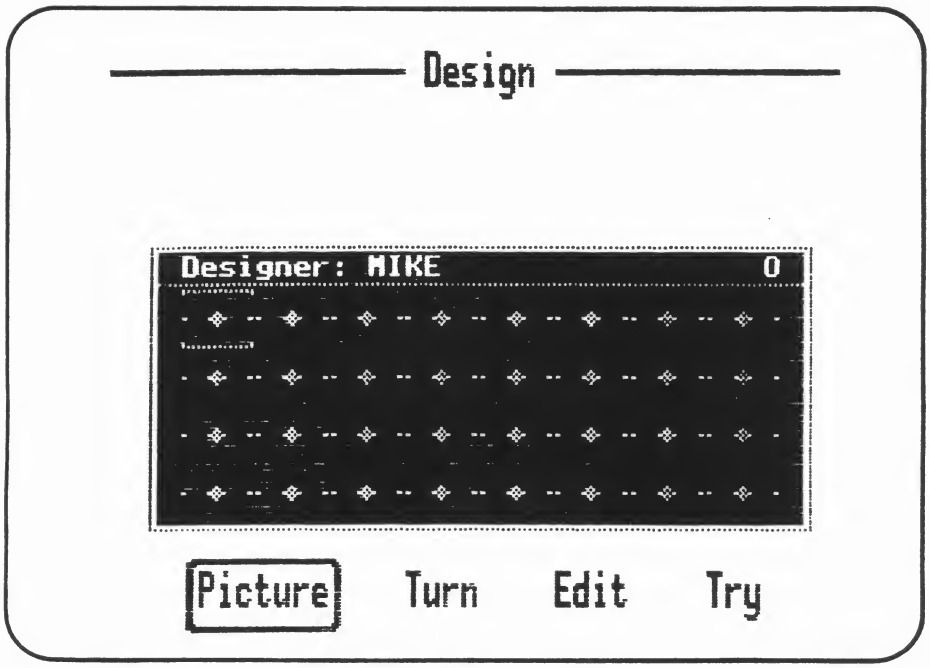
THE SUPER FACTORY
DESIGN



When you first enter the Design section, you will be asked to enter your name. To correct a spelling mistake, use the back-arrow key (←) or the DELETE key, then press RETURN (↵ on the IBM or Tandy). You may enter up to 16 letters.

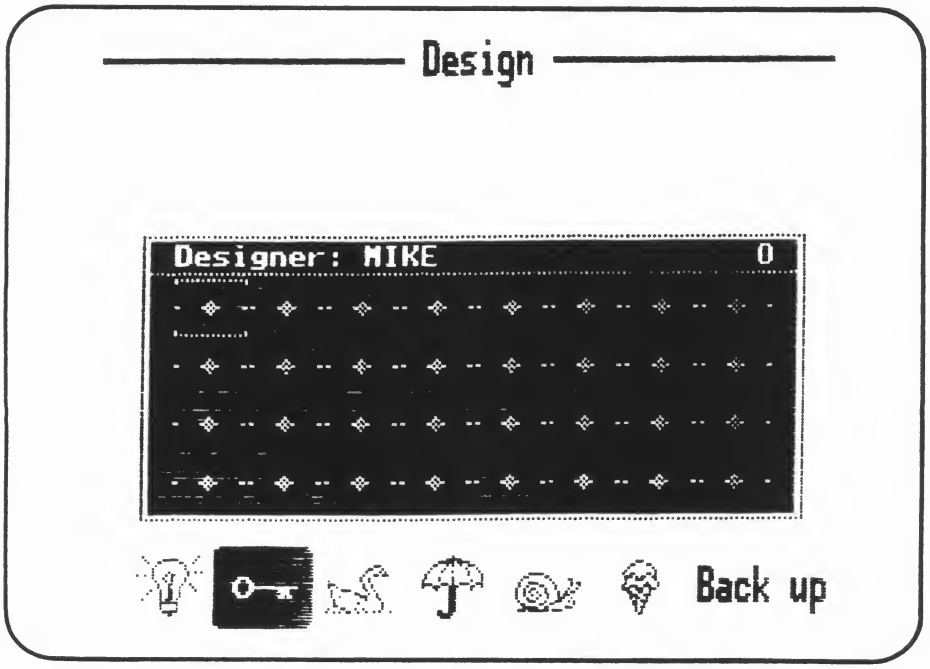
The Design section presents the student with a blank plan. The name of the designer is printed on the top left-hand corner of the plan. The number of steps used in the plan at any given time is shown on the upper right-hand corner of the plan.

In Design, you first design the cube with a series of pictures and turns. These steps will appear on the plan; not directly affecting the cube until the student tries the plan. Building the cube in this manner requires a level of abstraction not present in the Research section.

Four options appear at the bottom of the screen of the Design section: PICTURE, TURN, EDIT, and TRY. To select one of the four options, move the box by pressing the arrow keys and then press RETURN (↵ on the IBM or Tandy).

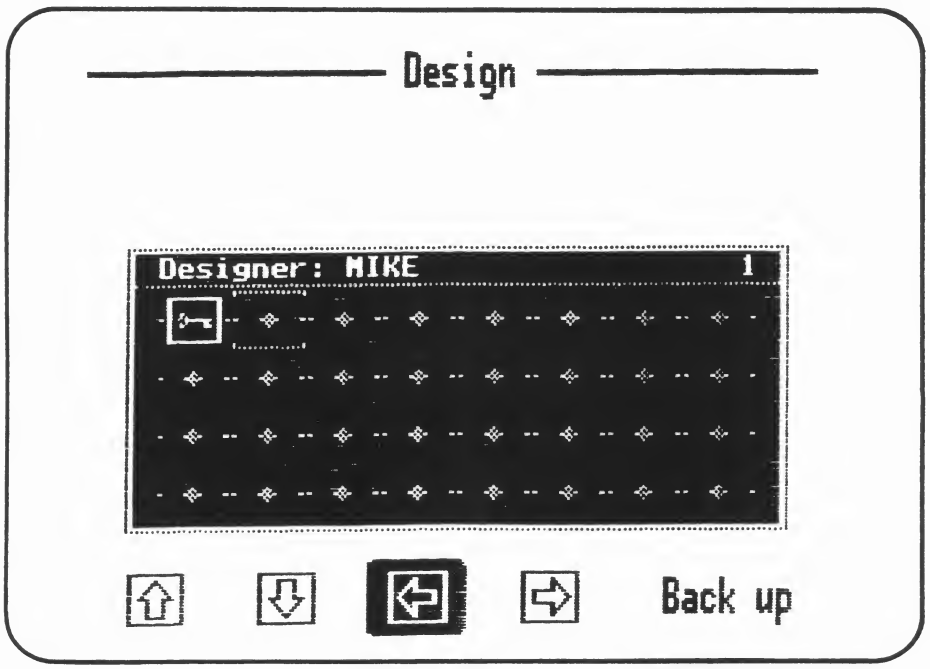
PICTURE: Six pictures and the words BACK UP are shown at the bottom of the screen. To select a picture, move the highlighting to that picture and press RETURN (↵ on the IBM or Tandy). The picture will appear in the upper left-hand corner of the plan. After having selected a picture, you are returned to PICTURE, TURN, EDIT and TRY.

If you choose the PICTURE option by mistake, you can select BACK UP. You will be returned to PICTURE, TURN, EDIT and TRY without selecting a picture.



If you want to change your set of six pictures, press the P key. As in Research, first select your new picture using the arrow keys and press RETURN (↵ on the IBM or Tandy). Then select the picture to be replaced and press RETURN (↵ on the IBM or Tandy). After you have made all the desired changes, select DONE. Remember, you can change the pictures by pressing the P key at any time in the program.

TURN: After selecting a picture, rotate the cube to put a picture on another face. To do this, select TURN. Four arrows and the words BACK UP will appear at the bottom of the screen.

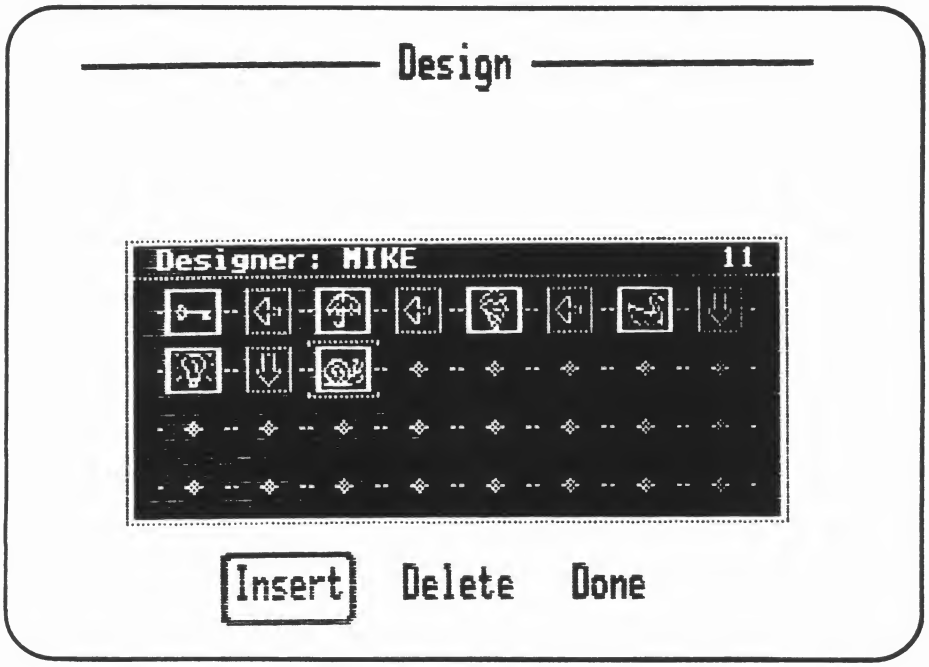


Move the highlighting to the desired arrow and press RETURN (↵ on the IBM or Tandy). The turn will appear as the next step on the plan.

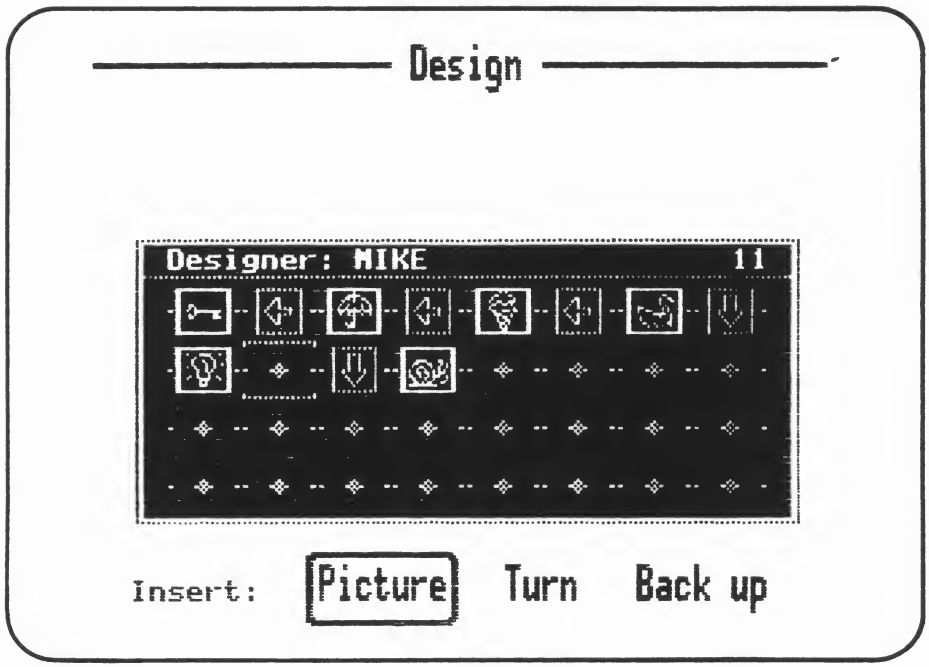
To rotate the cube more than once, choose TURN again. For example, to rotate the cube to bring the back face of the cube to the front, select TURN left followed immediately by another TURN left. The two turns appear one right after the other on the plan.

If you choose the TURN option by mistake, you can select BACK UP.

EDIT: If you make a mistake while planning, you can choose the EDIT option either to insert steps or delete steps from your plan. When EDIT is selected, three options are presented: INSERT, DELETE, and DONE. DONE will return to the PICTURE, TURN, EDIT, and TRY options.



INSERT: If INSERT is chosen, brackets will appear over a step (either a picture or turn) in the plan. Move the brackets using the arrow keys to a space where you want to insert a step, then press RETURN (↵ on the IBM or Tandy). The step within the brackets, and all the steps to the right, will move one space to the right. This creates a vacant space for a new step. At the bottom of the screen the options PICTURE, TURN and BACK UP will appear.



Choose either a picture or Turn to place in the plan. You can also choose to BACK UP. This brings you back to INSERT, DELETE, and DONE.

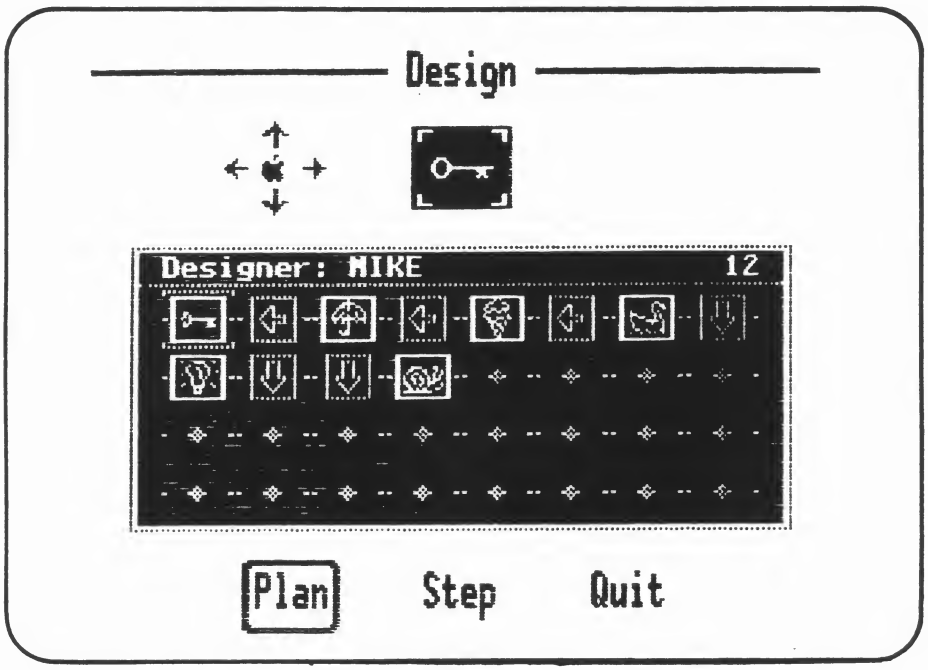
After you have inserted a step, you will be returned to the INSERT, DELETE, and DONE options. From this point, you can keep inserting or deleting. If you are finished editing, choose DONE.

DELETE: If DELETE is chosen, you move the brackets to the step to be deleted then press RETURN (↵ on the IBM or Tandy). The picture or turn within the brackets is erased and all the steps to the right of the brackets move one space to the left.

After deleting you are returned to the INSERT, DELETE, and DONE options.

TRY: To try your plan, move the box to TRY and press RETURN (↵ on the IBM or Tandy). Each step will be executed, thus placing a picture on the cube or rotating the cube.

After your plan has been tried, the cube is returned to the front face and three options are presented:



PLAN: Return to the plan to add to or edit the plan.

STEP: Move through the plan step-by-step. Press RETURN (↵ on the IBM or Tandy) to see the results of each step. When the steps are completed the cube is returned to the front face.

In addition, after you have tried your plan, you may view the cubes.

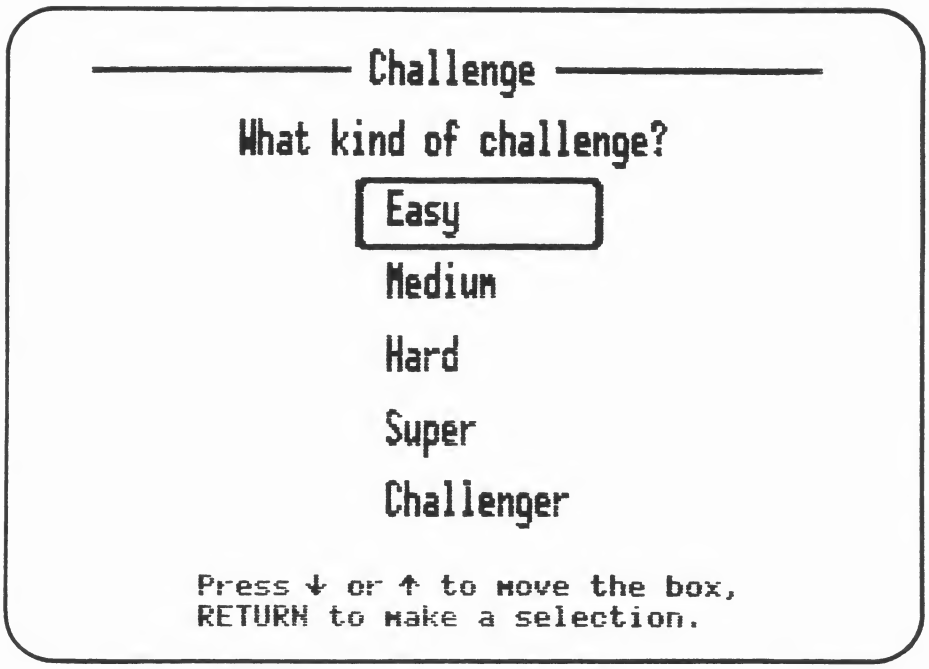
- On the Apple IIe or IIc, or IIGS, hold down the closed apple key (🍎) and press an arrow key.
- On the Apple II+, use the I, J, K and L keys to rotate the cube, instead of the closed apple and arrow keys.
- On the IBM or Tandy, the cube is rotated by holding down the SHIFT key and pressing an arrow key.

QUIT: Return to the main menu.

When you QUIT, you will be asked if you would like to save your design for the Challenge section. If so, your design will be saved under your name. (See the Change Option on page 23 for instructions on how to delete saved Challenges, or turn off the Save Option.)

You are then returned to the main menu. You can then choose to design another cube, go back to the Research section or go on to the Challenge section.

THE SUPER FACTORY
CHALLENGE



When you first enter the Challenge level, five levels of difficulty are presented: EASY, MEDIUM, HARD, SUPER, and, if any Challenges have been saved from the Design level, CHALLENGER. An EASY challenge consists of 2 or 3 pictures placed on the cube. One of the pictures will be on the front face, and the other(s) will be on an adjacent face. The rest of the faces are blank.

In the MEDIUM challenge, there will always be a picture on the front face and the back face and 1 or 2 pictures on adjacent faces. The picture on the back face of the cube may appear upside-down depending on the way you turn the cube. However, the back face can be accessed right-side up if the turns are made in the correct sequence.

In the HARD challenge, 5 or 6 pictures are placed on the faces. Many pictures, however, may appear upside-down or sideways. The front face will always be upright.

In a SUPER challenge, the same picture may be used several times. All pictures, including the front face, may be rotated on the faces of the cube. This makes the challenge very difficult.

In CHALLENGER, you can choose from up to 20 pre-saved cubes made in the Design section. Make a selection and press RETURN (↵ on the IBM or Tandy). If no challenges have been created, this option will not appear.

The difficulty of a level is also determined by the pictures used in creating the Challenge cube. If the pictures are rotationally symmetric, the design will be easier. The sets of pictures used can be controlled by pressing P before choosing a Challenge level, or through the Change Option (page 23). When the computer creates a Challenge, the cube is created from the current set of six pictures.

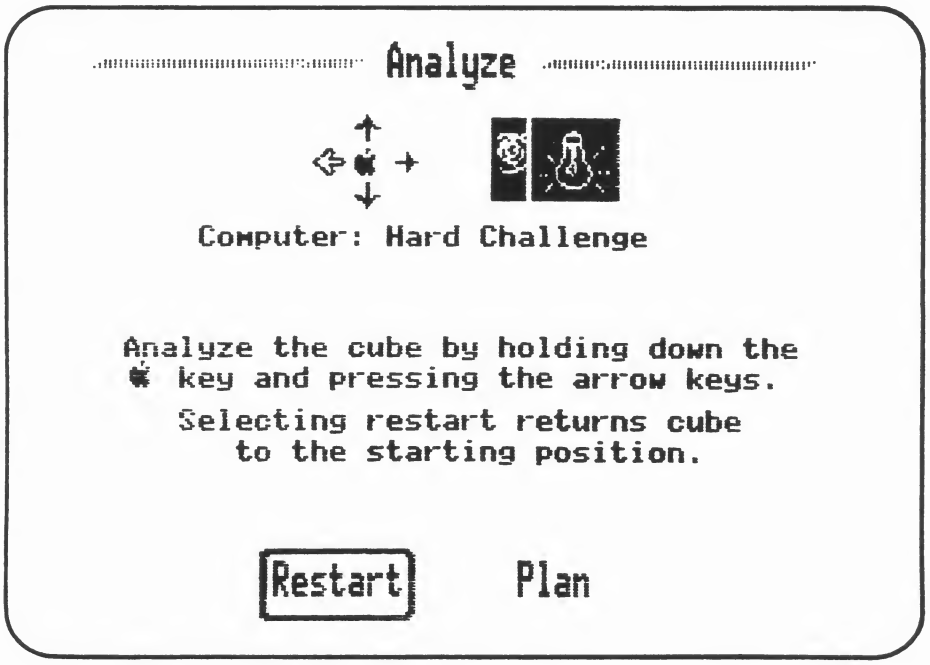
When asked, enter your name and press RETURN (↵ on the IBM or Tandy).

Follow the four steps of problem solving to duplicate the Challenge cube. The steps are:

1. Analyze the cube,
2. Plan your moves,
3. Try your plan, and
4. Check to see if your cube matches the Challenge cube.

Step 1: Analyze

In Analyze, the challenge cube will be rotating. Take notes showing the position of the pictures on the cube as it rotates.



After you have analyzed the cube, two options are available:

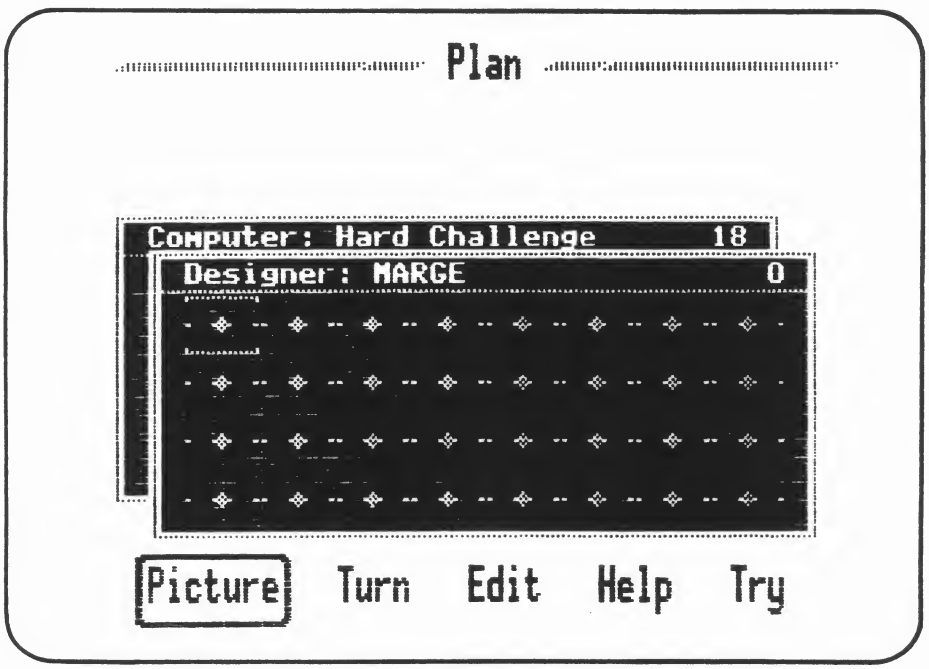
RESTART: Brings the cube back to the front face (noted by the marks in the corners). You can then rotate the cube yourself as follows.

- On the Apple IIe, IIc, or IIGS, hold down the closed apple key (🍎) and press an arrow key.
- On the Apple II+, use the I, J, K, and L keys.
- On the IBM or Tandy, hold down the SHIFT key and press an arrow key.

PLAN: Goes to the next level, Plan.

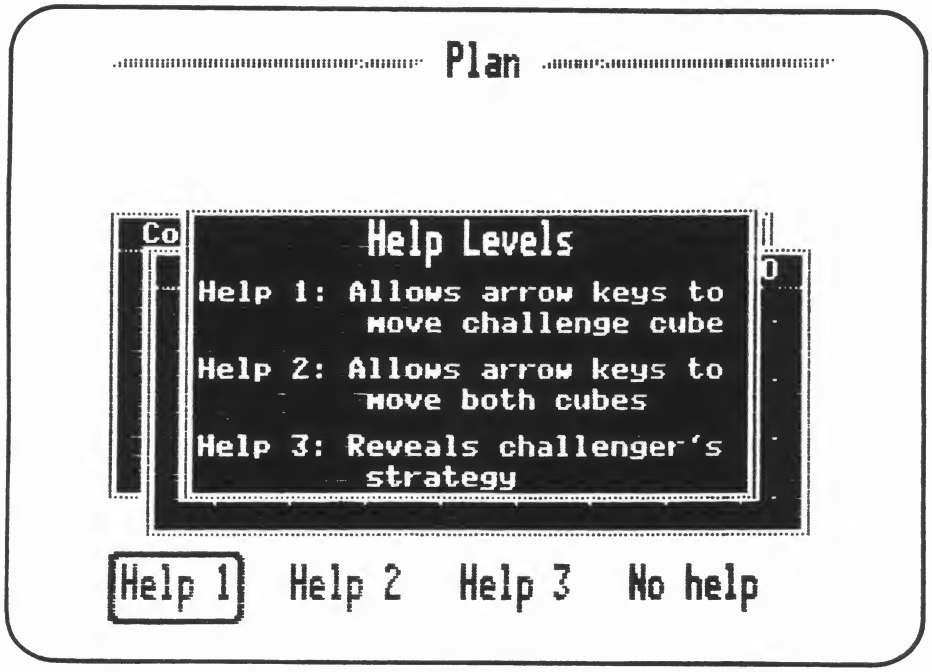
Step 2: Plan

In Plan, you are shown two plans. The plan in front is your plan, and the one behind is the computer's plan. The number of steps used in each plan is shown in the upper right-hand corner of the plan.



Within Plan, five options are available: PICTURE, TURN, EDIT and TRY function exactly as in the DESIGN section. Additionally, HELP is available.

HELP: Three levels of help are available. If you decide you do not want help, you can choose "No help" and return to Plan.

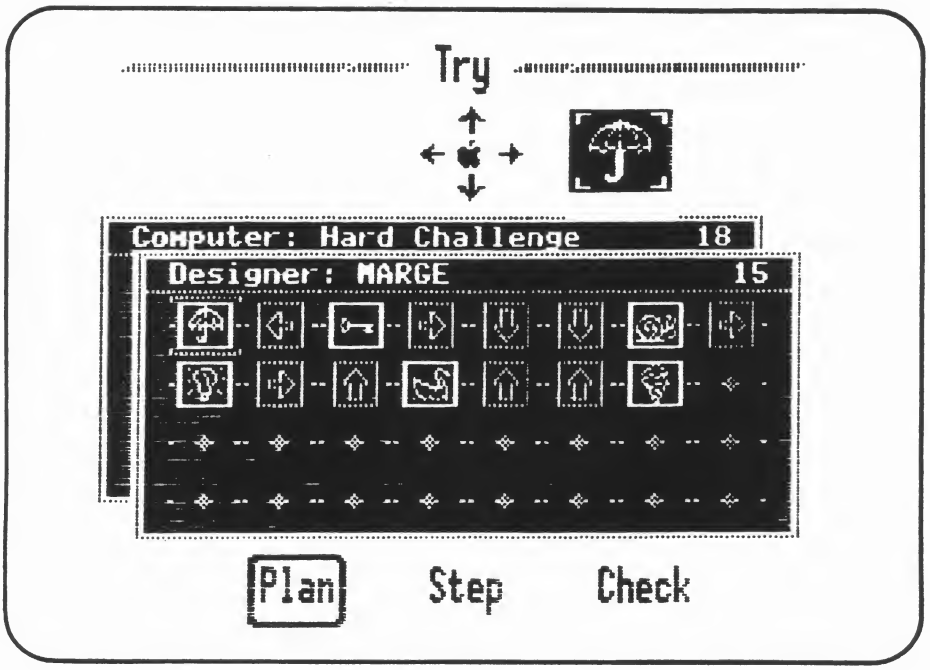


If Help 1 is chosen, the challenge cube will appear. You can then rotate the challenge cube. Help 1 is useful to view different sides of the challenge cube as you are devising a plan.

If Help 2 is chosen **both** cubes can be rotated at the same time. This option would be valuable after you have used the TRY option and have tried to execute your plan once.

If Help 3 is chosen, the computer or challenger's completed plan is revealed.

Step 3: Try



In Try, your plan will be implemented. After your plan has been tried, three options will be available:

PLAN: Returns to Step 2: Plan. If you think that your plan is wrong, you may want to go back and EDIT your plan. To have the computer evaluate your plan, you must go onto Step 4: Check.

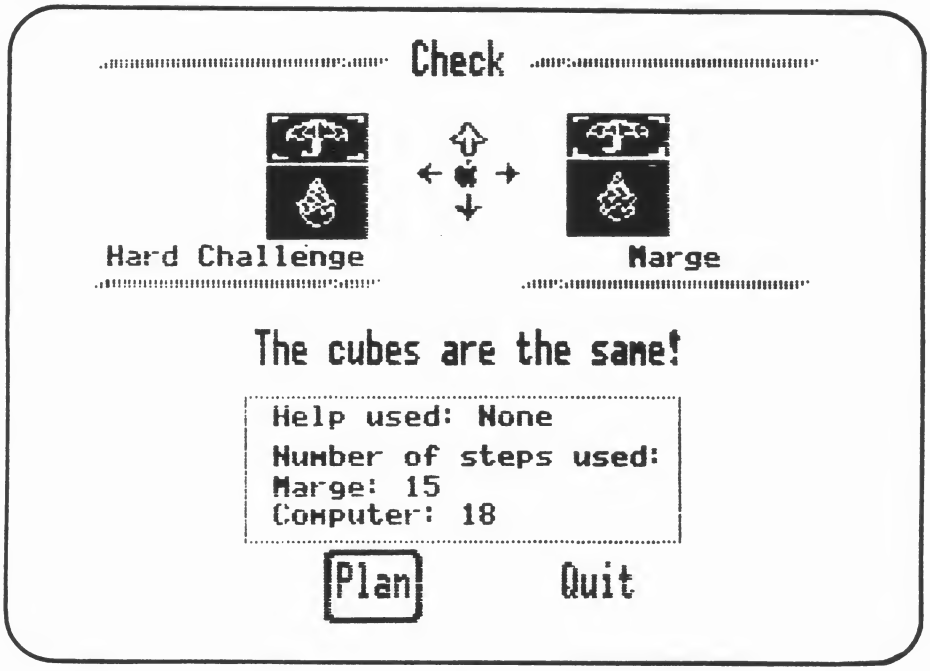
STEP: Moves through your plan step-by-step. Press RETURN (↵ on the IBM or Tandy) to see the results of each step. When the steps are completed, the cube is returned to the front face.

CHECK: Goes on to Check.

In addition, after you have tried your plan, you can view the different faces of the cube.

- On the Apple IIe, IIc, or IIGS the cube can be rotated by holding down the closed apple key (🍎) and pressing an arrow key.
- On the Apple II+, use the I, J, K and L keys to rotate the cube instead of the closed apple and arrow keys.
- On the IBM or Tandy, the cube is rotated by holding down the SHIFT key and pressing an arrow key.

Step 4: Check



In Check, the two cubes are compared. When evaluating the cubes, the program rotates the two cubes, making sure that the pictures on the student's cube are on the same faces, and have the same orientation as the Challenge cube.

After the cubes are checked, you can also rotate the cubes yourself in the following manner.

- On the Apple IIe, IIc, or IIGS, by holding down the closed apple key (🍎) and pressing an arrow key.
- On the Apple II+, use the I, J, K and L keys to rotate the cube instead of the closed apple and arrow keys.
- On the IBM or Tandy, the cube is rotated by holding down the SHIFT key and pressing an arrow key.

After viewing the results, you can choose to return to your plan or QUIT.

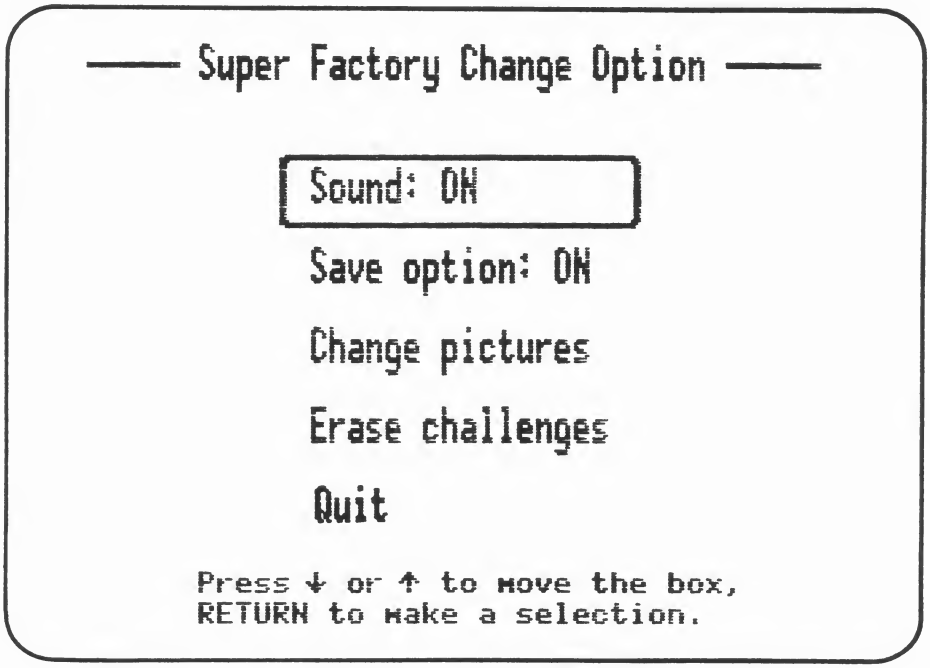
THE SUPER FACTORY
CHANGE OPTION

Another feature of *THE SUPER FACTORY* is the Change Option. The Change Option will allow you to:

- Turn off the sound
- Turn off the save option
- Change pictures
- Erase challenges

The Change Option is accessed by holding down the CONTROL key and pressing the T key from the main menu.

When the Change Option is selected, the Change Option menu appears:



To turn the sound off or on, move the box to "Sound" and press RETURN (↵ on the IBM or Tandy).

To turn the save option on or off, move the box to "Save option" and press RETURN (↵ on the IBM or Tandy). If the save option is turned off, the players will not be given the option of saving their challenges in the Design section. If you would like the students to use only a certain set of challenges, save these challenges, then turn off the save option.

CHANGE OPTION

You can choose the set of pictures that will appear when the students first enter the program by selecting "Change pictures". You may want to start the students with rotationally symmetric pictures and then move on to the asymmetric. To select the starting pictures, move the box to the desired picture and press RETURN (↵ on the IBM or Tandy). Move the highlighting onto the picture you want to replace and press RETURN (↵ on the IBM or Tandy). Continue until the pictures on the bottom of the screen are those that you want to use as your starting set. Move to DONE when you are through making selections.

If you select "Erase challenges", you will see a list of all the challenges which have been saved. Move the box to the challenge you wish to delete and press RETURN (↵ on the IBM or Tandy). That challenge will no longer be available. Move to DONE when you are through.

After selecting "Quit", you will be asked if you want to save the changes. If you answer NO, you will return to the main menu without making the changes.

Exiting the Program

When finished with the program, select End from the main menu.

You will be asked if you want to use another disk. If so, place the new disk in the drive and press RETURN (↵ on the IBM or Tandy).

THE SUPER FACTORY
CLASSROOM LESSONS

Overview

The uniqueness of *THE SUPER FACTORY* is reflected in the Classroom Lessons. Not only do the students become familiar with the properties of three-dimensional objects but, at the same time, they learn and apply the steps of problem solving.

The lessons allow the students to become actively involved in the learning process while gradually becoming acquainted with both areas.

The lessons are so constructed that it is advisable to start at Lesson #1 and progress to Lesson #4. It is possible, however, to use the lessons individually.

Briefly outlined, they are as follows:

Lesson #1 — Students explore three-dimensional objects in general, although the main focus deals with cubes.

They observe the effects of rotation. It is important for them to note the effects of rotation with respect to:

- the positioning of pictures on the faces of a cube relative to one another, and
- the individual positioning of each picture on each face of the cube.

Lesson #2 — Students are introduced to the four problem-solving steps. They are encouraged to apply them in duplicating cubes.

Lesson #3 — After having duplicated a number of cubes, students are introduced to a further property of three-dimensional objects which allows them to solve their problems more effectively. Three-dimensional objects are changed to two-dimensional figures.

Lesson #4 — Students review the problem-solving steps. They discuss and compare their strategies. They reflect on the different methods they used to solve the problem.

In the last lesson, the students are asked to go beyond their findings with the cube. They are encouraged to make predictions about problem solving with three-dimensional objects other than the cube. In doing so, they are transferring their knowledge from the specific, the cube, to the more general area of the three-dimensional world.

Classroom Lesson #1
Figures In Three Dimensions

OBJECTIVES

- to be able to imagine what a three-dimensional object looks like.
- given several views of a three-dimensional object, to be able to complete a new view.

MATERIALS

- Classroom sets of Activities #1, #2, and #3.

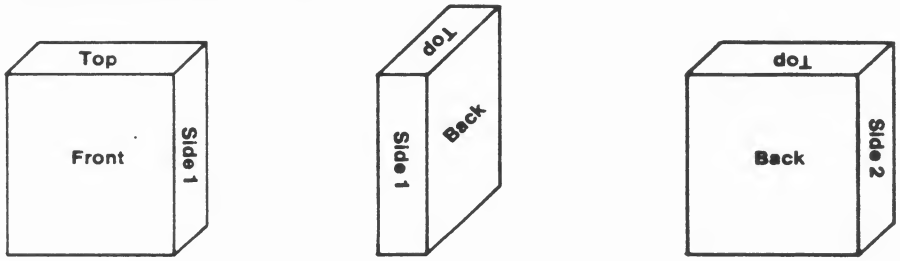
Lesson Plan

Preparation:

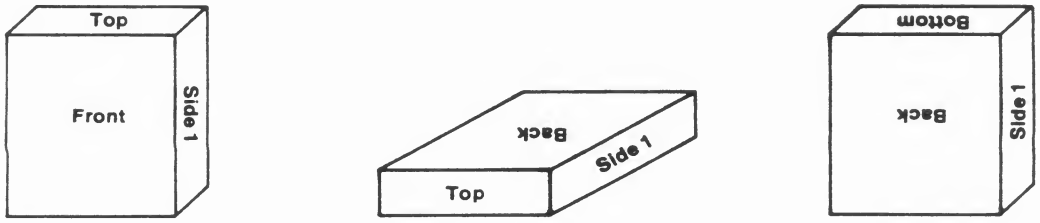
Show students three-dimensional objects. Turn and rotate the three-dimensional objects. Discuss with the students what happens when you rotate them in different directions.

For example, take a cereal box. Show students what happens to the writing on the box when you turn it from left to right or when you flip it from top to bottom.

Then turn the box around to the left.



Now flip the box over.



Discuss why the back of the box's lettering is readable in one case and upside down in another.

Ask students to draw both views on the blackboard. Start with the front position again and flip the box several ways. Draw the results. Go through several examples like the one above with the students.

Draw a view on the blackboard and see if students can turn the box to match that view.

Activities:

Hand out Activities #1, #2, and #3. You may want to do the activities one at a time. If students are having trouble, use a three-dimensional model to help them.

Follow-up:

When the students are done with the activities, do a classroom presentation using *THE SUPER FACTORY*. Go into the Research level. Select six pictures and put them on the cube. Turn the cube in some of the same ways you turned the cereal box. Start at the "front." Rotate to the left. Start at the "front" again. Rotate to the right. Have students predict:

> If I turn it down, what will appear?
> And if I turn it up?
> What happens if I turn it to the left and then up?

Select QUIT and research another cube. This time, type P to get the picture selection screen. Try different pictures. Ask students:

> Which pictures seemed easier to work with?
> Why?

Discuss the concept of symmetry. Explain:

> If you can rotate it 90, 180, or 270 degrees and it will not change appearance, the picture will be easier to work with.
>
> If you can turn the picture 180 degrees and it will match the original, you can probably make the cube in fewer steps than if the figure is asymmetrical.

Discuss:

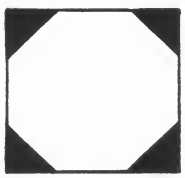
You may want to discuss symmetry with respect to the x-axis and y-axis. Can pictures be symmetrical to both the x-axis and to the y-axis, and not be symmetrical when they are rotated 90, 180, or 270 degrees: Try the figures below.

What other kinds of symmetry are there besides rotational symmetry?

Go to the Design section of *THE SUPER FACTORY*. Design several cubes with the students. Have them predict what the cubes will look like, i.e., how the pictures will appear on the cube.

Then have the students use Research and Design on their own or in teams. At this point, you may want to turn off the Save Option at the end of the Design section (see Change Option, page 23) so students do not save all their experiments.

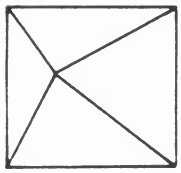
ACTIVITY #1
Can you Imagine?

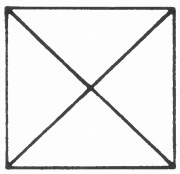


Describe what these figures look like.

How many white faces does it have?

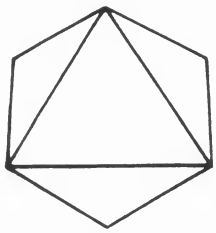
_____





How many triangular faces does this figure have?

_____

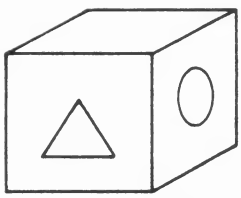


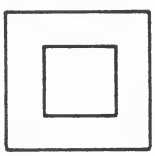
How many edges?

_____

How many square faces does this have?

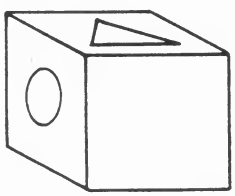
_____





How many corners?

_____



How many sides can you identify? What is on them?

_____

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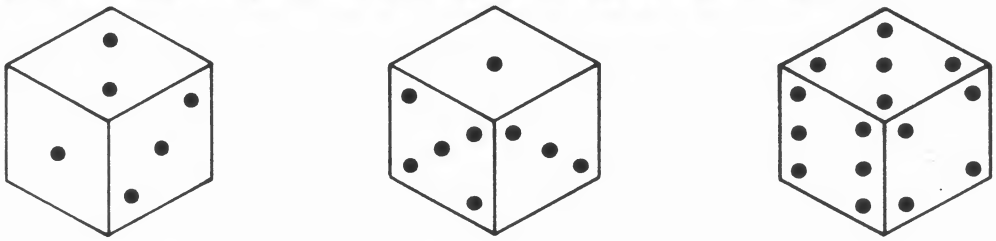
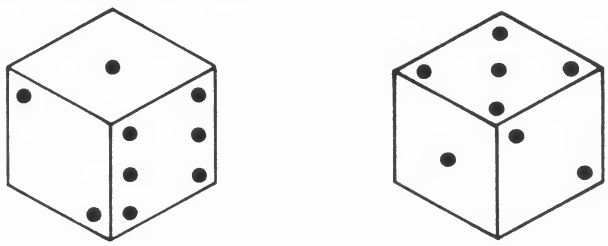
ACTIVITY #2
Which is Wrong?

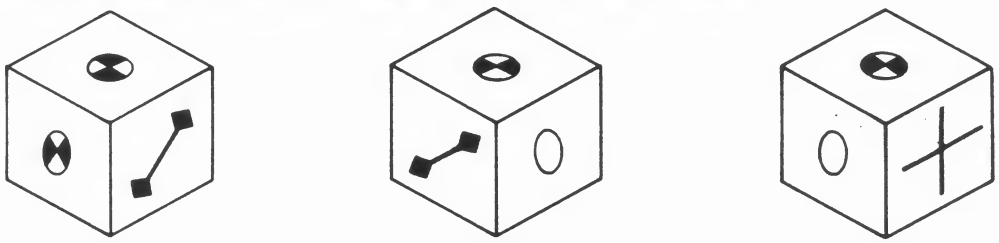
1. **Look at these three different views of the same cube.**



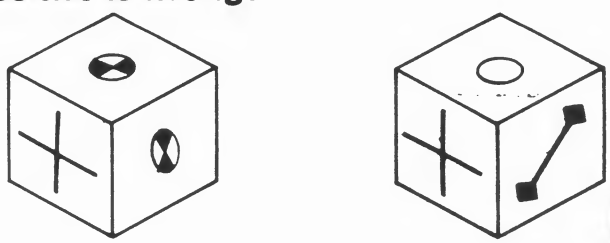
Which of these two is wrong?



2. **Look at these three different views of the cube.**



Which of these two is wrong?



Discard

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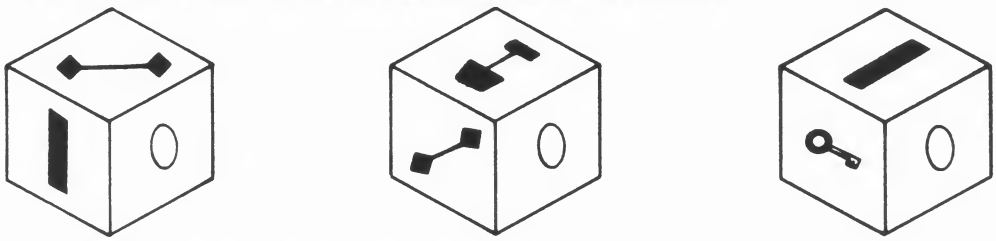
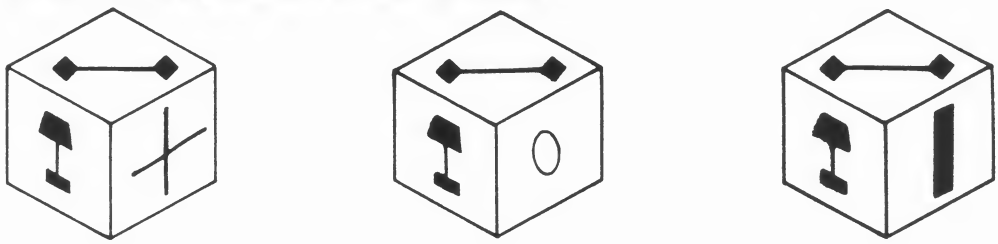
ACTIVITY #2
Page 2

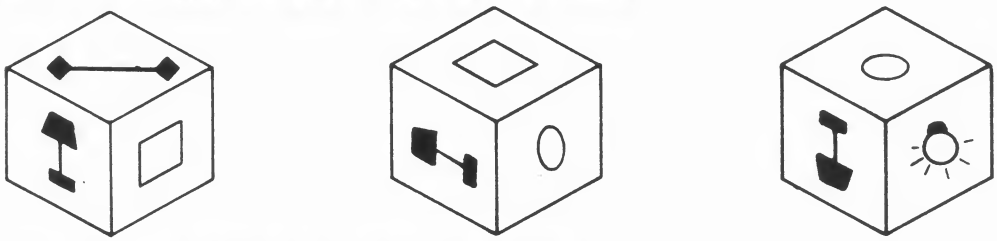
3. **Look at these three different views of the cube.**



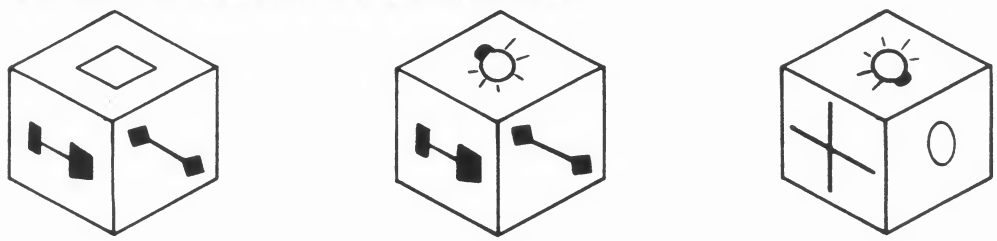
Which of these are the same cube?



4. **Look at these different views of a cube.**



Which of these are the same cube?



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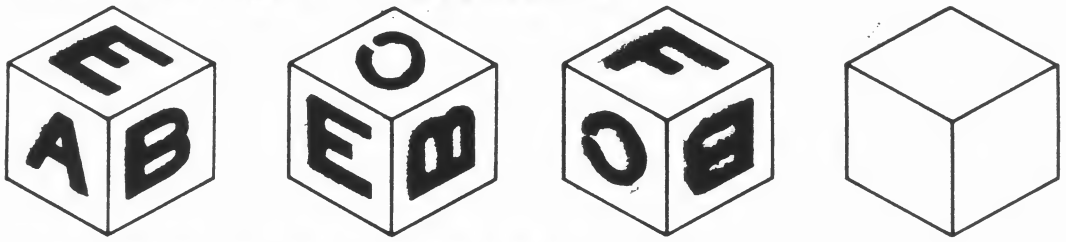
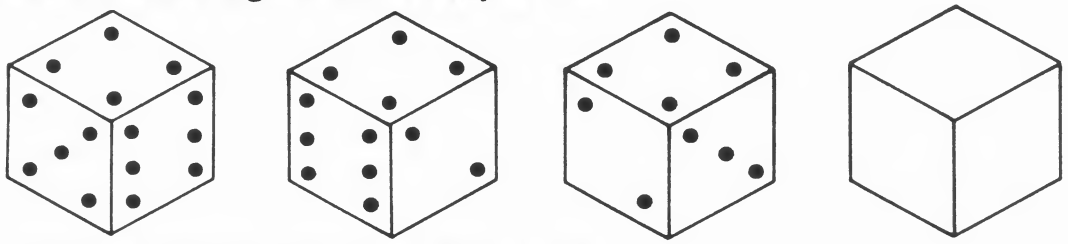
ACTIVITY #3
Cube Sequences

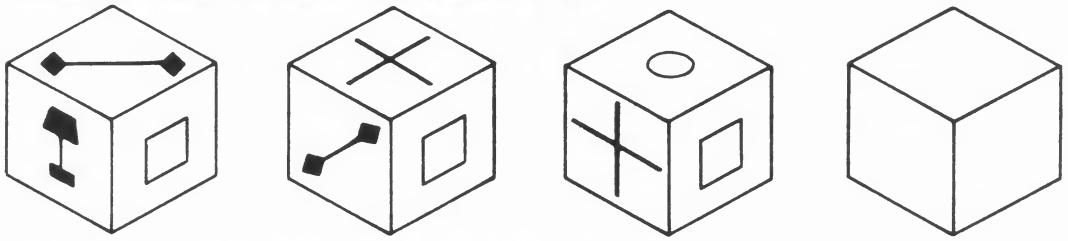
1. Draw the last figure in the sequence.



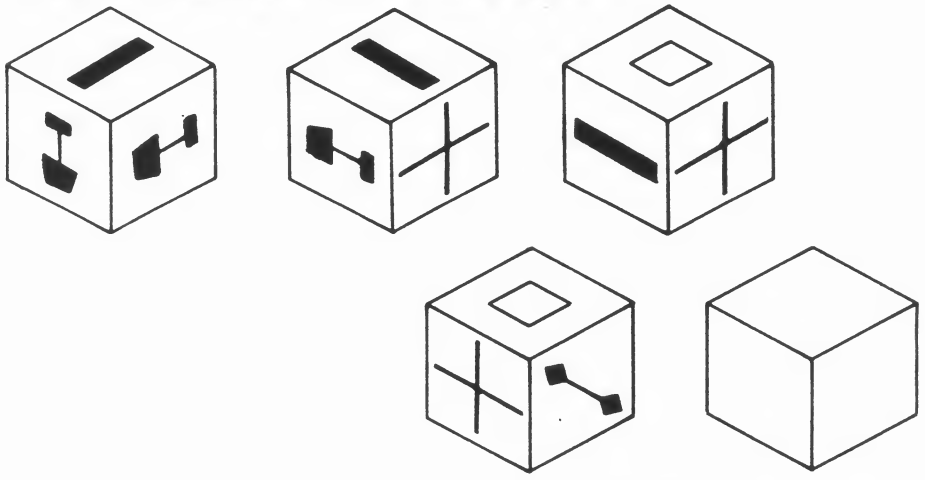
2. Draw the last figure in the sequence.



3. Draw the last figure in the sequence.



4. Draw the last figure in the sequence.



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Classroom Lesson #2
Problem-Solving Strategies

OBJECTIVES

- to teach students the four steps in problem solving.
- to reinforce these steps using *THE SUPER FACTORY*

MATERIALS

- Make a transparency of Activity #4.

Lesson Plan

Preparation:

G. Polya identified four steps to solve a problem in his book "How to Solve It." (Polya, G. How To Solve It. 2nd Printing. New Jersey: Princeton University Press, 1973.)

Review the steps in solving a problem with the students. Show the steps by using a transparency of Activity #4.

Step 1. Understanding the Problem

- What are the data?
- What are the conditions?
- Do you have enough information?
- Is it possible to solve?

Step 2. Devising a Plan

- Do you know a related problem?
- Have you seen this type of problem before?
- Can you restate the problem?
- What would you have to find out before you can solve it?
- Could you divide it into segments/parts and solve a part of the problem?

Step 3. Trying the Plan

- Carry out the plan, check each step.

Step 4. Looking Back

- Can you check the results?
- Could you do it a different way?
- Can you use what you learned in a different solution?

Activities:

Relate these steps to the third section of *THE SUPER FACTORY* by going to Challenge and doing an EASY problem.

Step 1. Understanding the Problem (Analyze)

- Discuss how you already found some things out about the mechanics of the problem by going through the first two sections of this program - Research and Design.
- What else should you know?
- Would it help to take some notes on what the cube looked like?
- Would it be helpful to make a three-dimensional model?

Step 2. Devising a Plan (Plan)

- Are there some things you could know about cubes to help with the problem?
- Could you break the problem down into two dimensions? Would that help?
- How could the three-dimensional model help you?

Step 3. Trying the Plan (Try)

- How could you carry out the plan and check it at each step?

Step 4. Looking Back (Check)

- The computer evaluates the cube. Have students think about:

  - How they could do it differently.
  - Was there a more efficient way to solve it?

Follow-up

Let the students use *THE SUPER FACTORY*. Have them tackle the EASY level in the Challenge section. If they do well, go on to the MEDIUM level.

After students have tried the section, teach them more about three-dimensional objects by using Lesson 3. Finally, after they have used the program several times, do Lesson #4 about Strategies.

ACTIVITY #4
Steps to Solve a Problem

1. Understanding the Problem

2. Devising a Plan

3. Trying the Plan

4. Looking Back

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Classroom Lesson #3
Changing Three Dimensions to Two

OBJECTIVES

- to be able to take a three-dimensional object apart and see it as a two-dimensional figure.
- to be able to visualize a two-dimensional representation as a three-dimensional figure.

MATERIALS

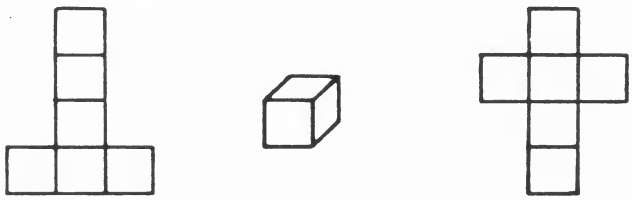
- Classroom sets of Activities #5, #6, #7, and #8.
- Construction paper, scissors, and paste/glue or transparent tape.

Lesson Plan

Preparation:

Duplicate Activity #5 on construction paper. Have students cut out one of the figures and paste or tape together a cube. Make sure all edges are pasted or taped together.

Now have them cut the cube along different edges until they get a flat piece of paper. See how many different basic figures students can devise that will make a cube.



Cut and paste or tape the cubes that have objects on them. Then again cut these along the edges. Find a way that these figures look right side up when they are in two dimensions.

Activities:

Do Activity #6. Have students cut out figures and paste or tape them together if time permits.

Have students do Activities #7 and #8.

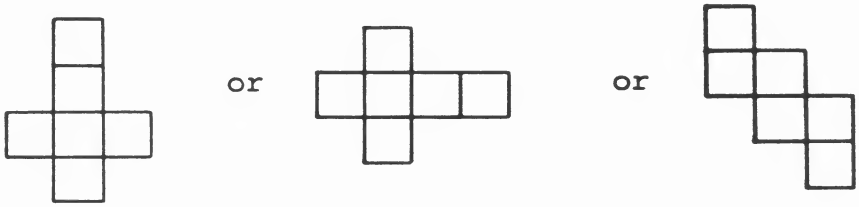
Follow-up:

Use *THE SUPER FACTORY* with the class. Do an EASY problem in the Challenge section. Analyze the figure. Have students draw a two-dimensional representation.

Go on to Plan, Try and Check.

Try a MEDIUM problem.

If you view this figure in two dimensions, would it have been easier to view it as:

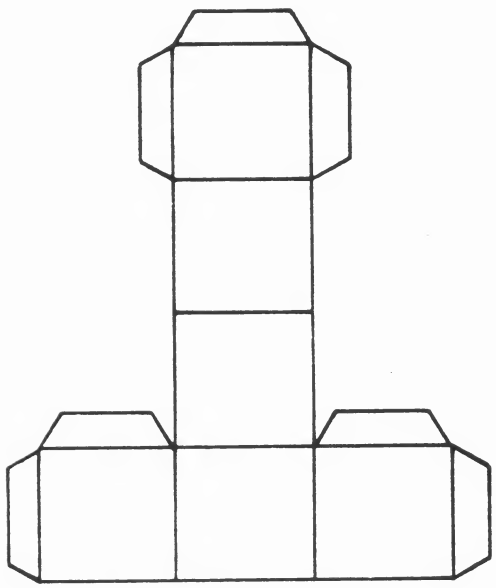


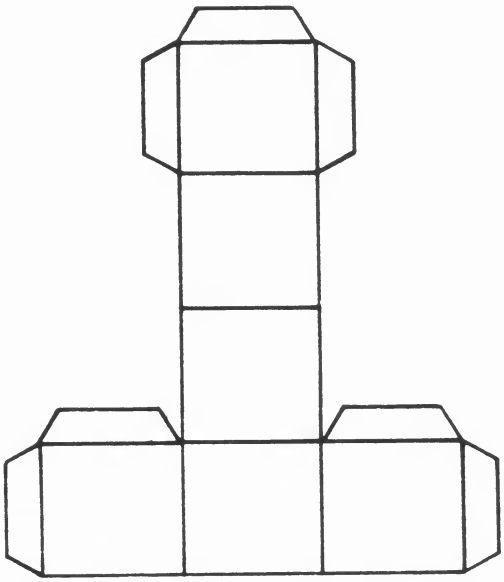
How could you tell?
Go on to Plan, Try and Check.

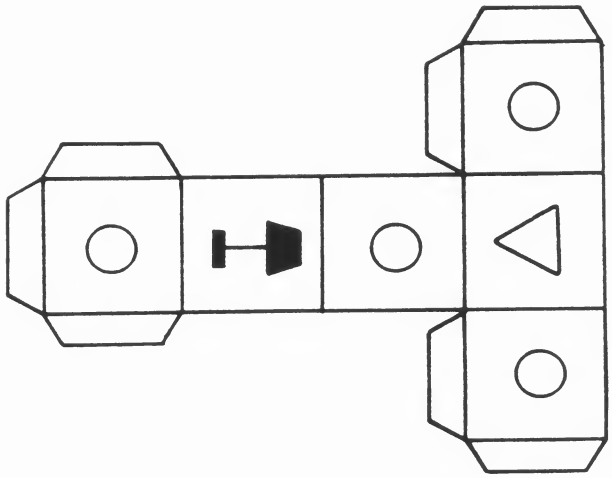
Try a HARD problem and then a SUPER problem.

Have the students try to solve at least five problems from each level of *THE SUPER FACTORY*. If they cannot solve them, use the HELP features in the program to get ideas for the solutions. Remind them that the problems are difficult and that they might get frustrated but to keep trying until they find a solution or call a friend over to help.

ACTIVITY #5
Cubes







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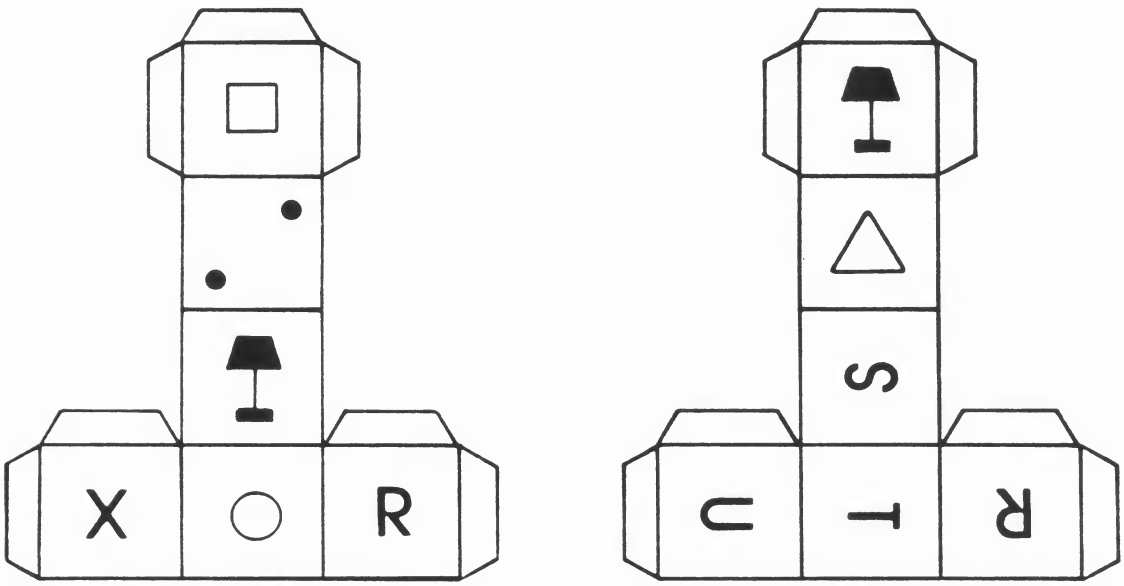
ACTIVITY #5
Page 2



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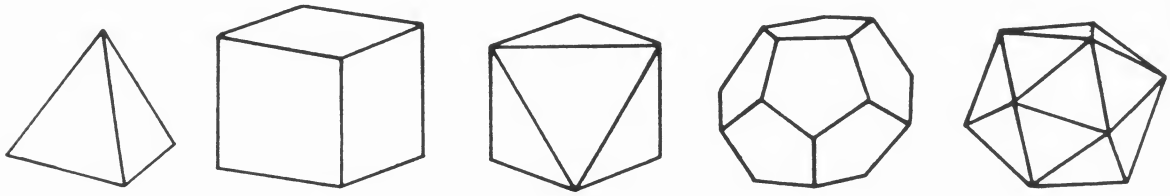
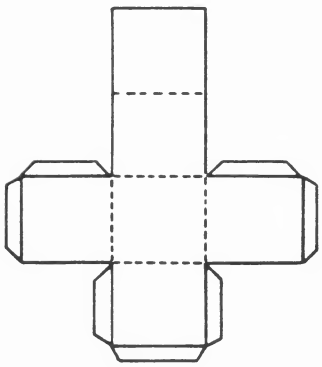
ACTIVITY #6
Solids

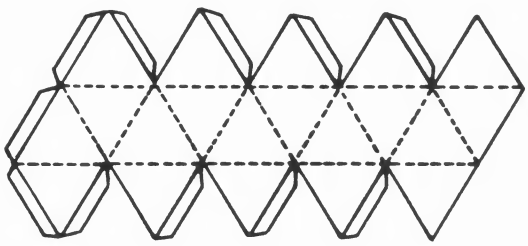
Match each pattern with the solid.



A B C D E



1



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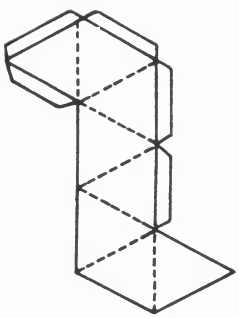

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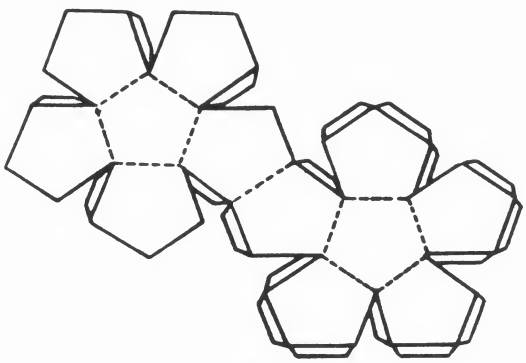
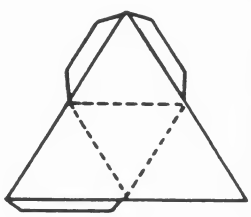


4



5

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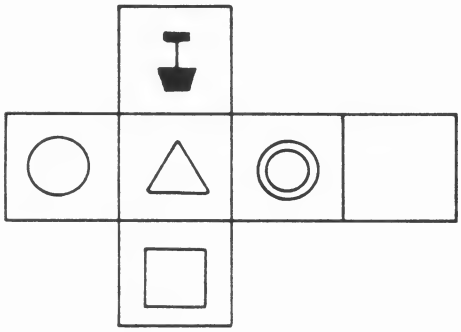
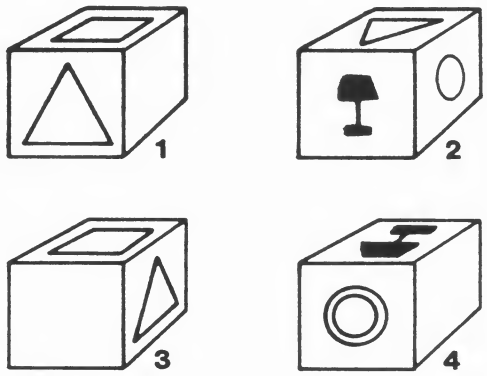
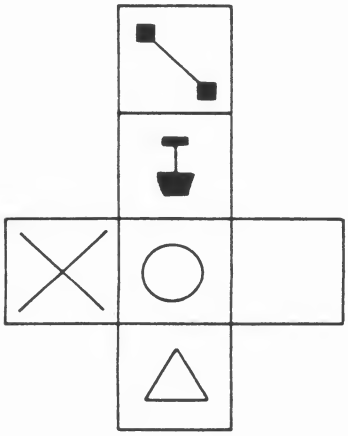
ACTIVITY #7
Folding

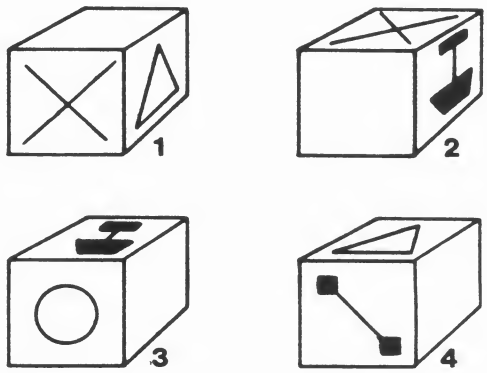
1. Fold the pattern into a cube. Which figure is correct.





2. Fold the pattern into a cube. Which figure is correct.





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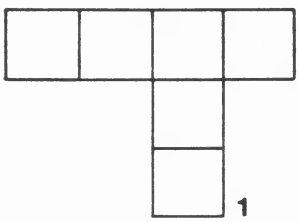
ACTIVITY #8
Will It Make A Cube?

Which patterns will fold to make a cube?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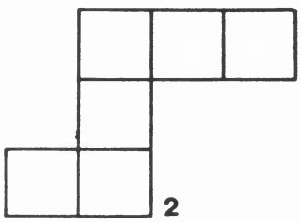
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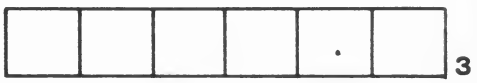
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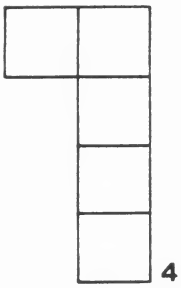
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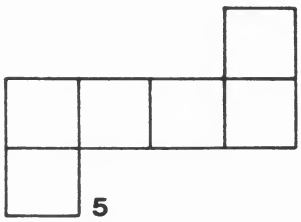
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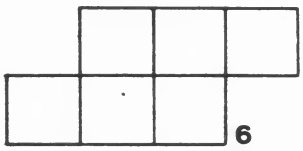
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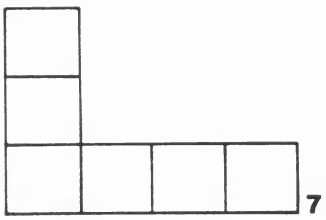
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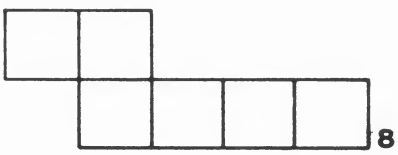
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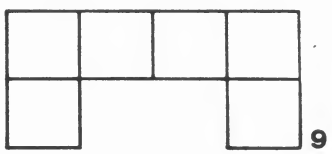
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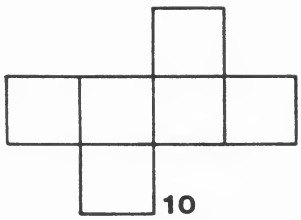
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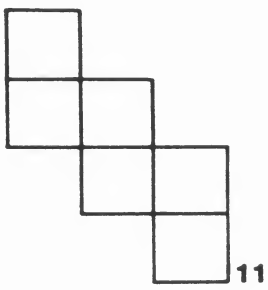
11

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Classroom Lesson #4
Solving THE SUPER FACTORY

OBJECTIVES

- to devise strategies in solving *THE SUPER FACTORY*.
- to discuss when to ask for help in solving a problem.
- to review the steps of problem solving.

MATERIALS

- None.

Lesson Plan

Preparation:

Students should have completed Lessons #1-#3 and spent some time using the program.

Review the steps in solving a problem with Activity #4.

Activities:

Using the computer with the entire class, choose the Challenge section of the program and any level problem.

Review for students.

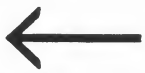
Step 1. Understand the Problem (Analyze)

Ask students:

How do you take notes on the figure shown? What did you learn that helps you analyze it? If you were solving the problem on your own and we hadn't discussed three-dimensional objects in class, how would you proceed?

Step 2. Devising a Plan (Plan)

Discuss strategies in planning.

e.g., if you have a light bulb sideways **and put it on the bottom of the cube** **and turn the cube so it is** **by a**  **turn so the light bulb is facing you. Then turn the cube up** **and the light bulb will be turned upright.**

Can you use this strategy on all figures that are not upright?

Discuss other strategies the students have found.
Ask students when they needed help.
Which help was the best? Why? (students may disagree)

Step 3. Trying the Plan (Try)

How many times did they try the plan before they could get the correct answer?

Step 4. Looking Back

Could they redo their plan in fewer steps?
What have they learned?

Follow-up:

Have students use the Design section and build their own Challenges.

Have other students play these Challenges. Can they do the Challenges in less steps?

Discuss with students if *THE SUPER FACTORY* is easier to solve now than the first time they attempted it. If so, why? If they had been tackling this problem on their own, how would they have gotten the information and strategies needed to solve it?

Discuss with students what would happen if you had a different three-dimensional figure besides the cube. What if you used a rectangular solid, would it be the same? What would happen with a tetrahedron (four-sided solid figure)? What about a pentahedron (five-sided figure)?

THE SUPER FACTORY
Sharing Some Field Test Observations

1. Start students with rotationally symmetric objects. These are easier to work with.

2. You may want to set up 5 or 6 predesigned challenges for students to work with in the Challenge level. The following was one sequence used by field-test teachers:

    1. A design with one picture which is rotationally symmetric on one face.

    2. A design with one figure which is not rotationally symmetric on one face.

    3. A design with two figures which are rotationally symmetric on the faces.

    4. Another design with two figures which are rotationally symmetric on the faces.

    5. A design with two figures that have 180 degree symmetry.

    6. A design with two figures which are not symmetric.

3. Many students preferred to work in collaboration, in groups of 2-3, rather than alone.

4. Having a manipulative, a cube, by the computer was extremely helpful.

5. Pencil and paper were also necessary for students to take notes as they analyzed the product.

6. Having the students analyze how they solved the problem is the objective of the program. The teacher had to solicit these responses from the students. Classroom discussions are a necessary part of the success of the program.

7. The ability of students to "imagine" the cube varied greatly. However, as students were taught an approach to solving the problem, the gap between students decreased.

APPLE: WORKING WITH YOUR COMPUTER

1. Turn on the television or monitor.
2. Insert the diskette into the disk drive with the label facing up and on the right.
3. Close the door to the disk drive.
4. Turn on the Apple II. (The on-off switch is on the back left side of the computer.)
5. You will see a red light on the disk drive turn on. If the disk drive light does not turn off in about 10 seconds, turn the Apple off and make sure your diskette is placed correctly in the disk drive.
6. The SUNBURST logo will appear on the screen, followed by the opening screen of the program.
7. Follow directions given in the program.
8. If you wish to stop during the program, hold down the CTRL (CONTROL) key and press E.

Turning Off the System

1. Remove the diskette from the disk drive and return it to its place of storage.
2. Turn off the Apple.
3. Turn off the television or monitor.

Apple IIGS: Control Panel Settings

To allow your Apple IIGS to work with Sunburst software, follow these instructions to set the Control Panel. The Apple IIGS saves the settings even after the power has been turned off.

1. Turn on the Apple IIGS and monitor.
2. Enter the Control Panel main menu (Figure 1) by holding down the CONTROL and OPTION keys, and then press RESET (the rectangular key located above the number keys). If your Apple IIGS is in an Apple //e case, use the closed-apple (🍎) key instead of OPTION.
3. Press the 2 key to set system standards.
4. Enter the Control Panel main menu again by repeating step 2.
5. Press the 1 key to enter the Control Panel.
6. Select "Display" by using the arrow keys ↓ or ↑ to move; press RETURN.
7. Using ↓ or ↑ to move, and ← or → to select, duplicate the Display Control Panel settings as shown in Figure 2.
8. After the Display options are set, press RETURN.
9. From the Control Panel, move to "System Speed" and press RETURN.
10. Use the arrow keys ← or → to select Normal speed; press RETURN.
11. From the Control Panel, move to "Slots" and press RETURN.
12. Using ↓ or ↑ to move, and ← or → to select, duplicate the Slot settings as shown in Figure 3. Press RETURN.
13. From the Control Panel, move to "Quit" and press RETURN.
14. To load and use a Sunburst disk, refer to "Apple: Working with the Computer."

1=Enter the Control Panel
2=Set system standards and 60 Hertz
3=Set system standards and 50 Hertz
4=Continue restarting the system

Press 1, 2, 3 or 4 to continue.

Figure 1

Control Panel
Display

Type: Color
√ Columns: 40
-Screen Colors-
√ Text: White
Background: Black
Border: Black
Standards: No

-Hertz: 60-

Figure 2

Control Panel
Slots

√ Slot 1: Printer Port
√ Slot 2: Modem Port
√ Slot 3: Built-in Text Display
√ Slot 4: Mouse Port
√ Slot 5: Smart Port
Slot 6: Your Card
√ Slot 7: Your Card

Startup Slot: 6

Figure 3

IBM PC/PCjr: WORKING WITH YOUR COMPUTER

1. Place the diskette in the computer's disk drive with the label facing up and on the right. (If there are two disk drives, place the diskette in the one on the left.) Close the door of the disk drive.

2. Turn on the graphics monitor.

3. Turn on the computer. In several seconds, you will see the red light on the disk drive light up and you will hear the disk drive spinning.

4. The SUNBURST logo will appear on the screen, followed by a menu of the program.

5. Follow the instructions in the program.

6. If at any time during the program you want to stop, hold the CONTROL (CTRL) key and press the E key.

Turning Off the System

1. Remove the diskette from the drive and put it in a safe place.

2. Turn off the computer.

3. Turn off the graphics monitor.

TANDY 1000: WORKING WITH YOUR COMPUTER

1. Place the diskette in the computer's disk drive with the label facing up and on the right. (If there are two disk drives, place the diskette in the one on the bottom.) Close the door of the disk drive.

2. Turn on the monitor.

3. Turn on the computer. In several seconds, you will see the red light on the disk drive light up and you will hear the disk drive spinning.

4. The SUNBURST logo will appear, followed by the opening screen.

5. Follow the instructions in the program.

6. If at any time during the program you want to stop, hold down the CTRL (CONTROL) key and press the E key.

Turning Off the System

1. Remove the diskette from the disk drive and return it to its place of storage.

2. Turn off the computer.

3. Turn off the monitor.

"WHAT HAPPENS IF...?" -- SUNBURST COURSEWARE AND WARRANTY

1. What happens if a program will not load or run?
   Call us on our toll-free number and we will send you a new diskette.

2. What if I find an error in the program?
   We have thoroughly tested the programs that SUNBURST carries so we hope this does not happen. But if you find an error, please note what you did before the error occurred. Also, if a message appears on the screen, please write the message down. Then fill out the evaluation form or call us with the information. We will correct the error and send you a new tape or diskette.

3. What happens if the courseware is accidentally destroyed?
   SUNBURST has a lifetime guarantee on its courseware. Send us the product that was damaged and we will send you a new one.

4. How do I stop the program in the middle to go on to something new?
   These programs can be ended at any time by holding the CONTROL (CTRL) key and pressing the E key. To change diskettes, select the End option on the menu and insert a new diskette.

5. Can I copy this diskette?
   The material on the diskette or cassette is copyrighted. You <u>should</u> <u>not</u> copy the courseware.

6. Can I take this diskette out of the computer after the program has been loaded and put it into another computer?
   Yes.